Answer on Question 51080, Physics, Mechanics | Kinematics | Dynamics

Question:

An uncharged parallel-plate capacitor having a dielectric of constant K is connected to a similar air filled capacitor charged to a potential V. The two capacitor share the charge and the common potential is V'. The dielectric constant is:

1) $\frac{V'-V}{V'+V}$

2) $\frac{V'-V}{V'}$

3) $\frac{V'-V}{V}$

4) $\frac{V-V'}{V'}$

Solution:

By the definition of the capacitance of a parallel-plate capacitor we have:

$$C = \frac{q}{V},$$

where C is the capacitance of a parallel-plate capacitor, q is the charge and V is the voltage between the plates.

Let us write the capacitance and initial charge for both capacitors. The first one is uncharged parallel-plate capacitor having a dielectric of constant K, and because of this capacitor is uncharged we can write:

$$C_1 = KC, q_1 = 0.$$

The second one is a similar air filled capacitor charged to a potential V, so we can write:

$$C_2 = C, q_2 = CV.$$

Then, from the condition of the question, we know that the two capacitor share the charge and the common potential is V'. Thus, we can write the final charges:

$$q_1' = C_1 V = KCV',$$

$$q_2' = C_2 V = CV'.$$

Therefore, we get:

$$q_1 + q_2 = q_1' + q_2',$$

$$0 + CV = KCV' + CV',$$

$$CV = CV'(K + 1),$$

$$\frac{V}{V'} = K + 1,$$

$$K = \frac{V}{V'} - 1 = \frac{V - V'}{V'}.$$

Answer:

4) $\frac{V-V'}{V'}$.